Supplement 1: Work for Sponsors other than DOE

Part of our work is supported by sponsors other than DOE. Major sponsors include the Nuclear Regulatory Commission, Department of Defense, Department of Health and Human Services, Department of the Interior, Environmental Protection Agency, Federal Emergency Management Agency, Department of State, Department of Transportation, Department of Agriculture, National Science Foundation, National Aeronautics and Space Administration, Electric Power Research Institute, private firms, universities, and state governments. (See Chapter VI for program funding.)

In the area of national security, we perform a wide range of work funded by federal organizations other than DOE. In the future, sponsorship of some follow-on work will be shifted to the new Department of Homeland Security. Discussion in this edition of Argonne's *Institutional Plan* is organized according to the sponsoring agency in early FY 2003. Future editions will discuss the Department of Homeland Security in detail. Currently, Argonne provides training, technical support, and R&D in the general area of national security for the Defense Threat Reduction Agency, Nuclear Regulatory Commission, Army, Air Force, Navy, Federal Emergency Management Agency, Federal Aviation Administration, Department of Transportation, Department of Agriculture, Federal Transit Administration, and other federal organizations.

Our work for non-DOE sponsors supports accomplishment of our mission (see Chapter II) and development of our initiatives (see Chapter III). From a national perspective, this "work for others" (WFO) allows our unique facilities and capabilities to be applied to national security needs and other R&D priorities.

Our WFO strengthens resources available for DOE missions and programs and promotes development of specific energy and environmental technologies. Furthermore, this WFO enhances our research capabilities, helps support the infrastructure at the Laboratory, and ultimately increases opportunities to transfer our technologies to productive applications in the private sector. Argonne does not undertake work for non-DOE sponsors if that work can be performed satisfactorily by private organizations.

A. Nuclear Regulatory Commission

We conduct research for the Nuclear Regulatory Commission (NRC) under a legislatively mandated memorandum of understanding between DOE and the NRC. Most of our work for the NRC has for many years involved supporting the Office of Nuclear Regulatory Research in its development of rules regarding plant safety and the condition of physical components. The largest efforts have addressed materials issues, steam generator tubing degradation, high-burnup fuel, and severe-accident behavior. Recently Argonne performed studies to enhance environmental pathway models for analyzing the transport of residual radioactive contaminants and develop parameters suitable for implementing NRC rules designed to assure public health and safety at nuclear facilities during the termination of licensed operations. We are now preparing portions of supplemental environmental impact statements for the renewal of reactor operating licenses. In addition, Argonne provides technical assistance to the Office of Nuclear Reactor Regulation and to the Office of Nuclear Materials Safety and Safeguards.

Both the research and the technical assistance performed for the NRC take advantage of the Laboratory's hot cells and its special capabilities in nuclear reactor technology, technical evaluation, systems analysis, materials science, computer code development, environmental risk modeling, and assessment of environmental and health impacts. Argonne's work helps to ensure that U.S. nuclear power plants will continue their safe and efficient production of electricity without emission of carbon dioxide.

1. Office of Nuclear Regulatory Research

Our materials research focuses on the degradation of structural materials in light-water reactors caused by reactor environments, including the effects of water chemistry and neutron irradiation. These studies include measurements of (1) growth rates of stress corrosion cracks in irradiated and nonirradiated materials and (2) the fatigue life of stainless and ferritic steels used in the reactor core, piping, and pressure vessel. Results from these studies are used by the NRC to ensure the structural integrity of plants as they age. Currently, we are examining portions of a leaking nozzle and a degraded pressure vessel head from the Davis Besse plant.

A comprehensive study of degradation in the steam generator tubing of nuclear power plants is under way. Critical areas being addressed include (1) evaluation of techniques used for in-service inspection of steam generator tubes and recommendations for improving the reliability and accuracy of those inspections, (2) validation and improvement of correlations and models for predicting degradation in aging tubes during operations, and (3) investigation of the potential for environmental degradation of Alloy 690, which has been used in most replacement generators in the United States.

Argonne is investigating the behavior of high-burnup nuclear fuels for the NRC. To reduce operating costs and minimize the accumulation of spent fuel, nuclear utilities are striving to increase the burnup of their nuclear fuels. However, at high burnups, fuel pellets and cladding are potentially less resistant to damage under some conditions. These considerations may necessitate modification of (1) fuel rod damage criteria used in NRC regulations and (2) materials properties assumed in safety analyses. Furthermore, new alloys and fabrication procedures designed to counter burnup effects may also affect regulatory criteria and safety analyses. To help address these issues, Argonne is determining the behavior of high-burnup fuel under accident conditions where coolant is lost and is establishing a database for the mechanical properties of high-burnup cladding, which is needed for licensing safety analyses. The Laboratory is also investigating the way high burnup might affect cladding and the behavior of spent fuel during long-term dry storage, a strategy now being employed at the sites of many nuclear power plants.

The NRC continues to use Argonne's broad expertise in severe-accident phenomena. The Commission was a partner in the recently completed Melt Attack and Coolability Experiment (MACE) program, which was organized by the Electric Power Research Institute. The Laboratory's contributions to this program are described in Section S1.E.1. The NRC will continue to rely on Argonne's expertise in this area through participation in the Melt Coolability and Concrete Interaction program, which is a follow-on to MACE sponsored by the Organization for Economic Cooperation and Development (see Section S1.E.5).

The NRC license termination rule assures public health and safety at nuclear facilities during the termination of licensed operations. To support the development of implementation guidance for this rule and an associated standard review plan, the NRC is using the Argonne software RESidual RADioactivity (RESRAD), expansion of which it sponsored earlier. The expanded program will specifically address the cleanup of contaminated sites and buildings during the decontamination and decommissioning (D&D) of facilities. The software was originally developed for DOE to help analyze environmental remediation at DOE sites. The NRC-sponsored work extended the existing models to include probabilistic dose analyses, thereby allowing NRC licensees to demonstrate compliance with the license termination rule and supporting NRC evaluation of the licensees' applications for facility termination.

We are initiating work on an alternative siting rule for NRC to use in evaluating new reactor sites. This rule will be used to evaluate alternatives in the early site permit and combined license applications submitted to NRC.

2. Office of Nuclear Reactor Regulation

Argonne assists the Office of Nuclear Reactor Regulation in a variety of areas related to aging and the performance of materials, components, structures, and systems in nuclear power plants.

This work helps assure that safety will be maintained as plant components age.

Argonne provides technical support to the NRC in the review of license renewal applications in areas including fatigue of metal components, thermal fatigue of cast austenitic stainless steels, irradiation-assisted stress corrosion cracking, and irradiation-induced void swelling.

We participate on interlaboratory teams preparing supplemental environmental impact statements related to the renewal of nuclear plant operating licenses. These analyses have covered issues of land use, ecology, and air quality that are related to continued power plant operations.

The Laboratory is reviewing aging effects and their management for nuclear plant systems, structures, and components that must meet license renewal rules. Previous work contributed to the development of a report and an associated standard review plan that serve as guidance documents for NRC reviews of license renewal applications. The Laboratory is currently updating and revising this guidance. Argonne also provides other kinds of technical support to the Office of Nuclear Reactor Regulation.

3. Office of Nuclear Materials Safety and Safeguards

For the Office of Nuclear Materials Safety and Safeguards, we are modeling environmental and health effects from uranium recovery operations to help the NRC (1) deal with changes in regulatory requirements and (2) consider revisions of existing licenses and applications for new licenses for uranium mining and processing. Enhancements of the current model will take into account *in situ* uranium leaching technology and associated processing. A key issue is the transport of uranium and decay product radionuclides (including radon gas), as well as the associated environmental and health impacts. At the same time, we are developing an Internet-based communication mechanism to facilitate distribution of the software code for the model and the NRC's interaction with prospective licensees. In other work, we are helping to prepare an environmental impact statement for construction and operation of a mixed-oxide fuel fabrication facility to be built at the DOE Savannah River Site. The facility will convert surplus weapons-grade plutonium into mixed-oxide fuel suitable for irradiation in light-water reactors.

B. Department of Defense

Argonne conducts research for several organizations within the Department of Defense (DOD).

1. Office of Secretary of Defense

We assist in developing components for the Joint Warning and Reporting Network, using the Laboratory's maps and data browser system to display active, vector-based spatial data from sensors and models.

2. U.S. Air Force

The U.S. Air Force sponsors several programs at Argonne. Our experience and expertise in conducting environmental assessments of sites with unique environmental features or unique potential impacts are being used for several major proposed Air Force activities.

We are studying biodiversity at a number of Air Force installations across the country, focusing on the abundance of federal- and state-listed species and on the existence of exceptional natural communities. The information collected is incorporated into geographic information systems.

We also perform studies to identify for the Air Force the most cost-effective technical approaches to environmental management. For the Air Force Materiel Command, we are developing innovative approaches to computer-assisted management of large numbers of air pollutant emission sources in complex industrial areas. For the Air Force Center of Excellence, we are developing approaches for assuring that Air Force actions conform to state and local air quality maintenance strategies. New approaches to environmental management will shift the emphasis from compliance to pollution prevention. In addition, we are assisting the Pacific Air Force in its implementation of novel,

cost-effective methods of carrying out environmental stewardship, including the management of cultural and natural resources at military installations in the United States and abroad.

We support a number of programs that serve Air Force Headquarters weather programs. For the Air and Space Natural Environment Executive Agent, we evaluate technologies and procedures for the Integrated Natural Environment Authoritative Representation Program. This program generates authoritative environmental databases and models for use by the DOD modeling and simulation community. For the Air Force Combat Climatology Center, we are continuing our development of the Weather Effects for the Warfighter system, an operational planning tool for assessing the impact of the environment on military systems and operations. Also for the Combat Climatology Center, we are developing a cluster-based, mesoscale weather forecasting system for use in training and simulation. Simulated weather forecasts from this system will provide a rich training environment for staff weather officers.

As an extension of an earlier project, we are customizing an enhanced version of an advanced information tool to assist the Secretary of the Air Force, Office of the Inspector General, in handling requests made under the Freedom of Information Act. We are also conducting R&D on advanced battery technologies for the U.S. Air Force. This work includes fundamental investigations of the mechanisms for ion conduction in new battery materials and the design and optimization of battery cells based on these materials.

3. The Joint Staff

We support the J-8 Directorate of the Joint Staff by evaluating emerging technologies and applying them to the mission challenges faced by the Joint community in the area of information management for modeling, simulation, and analysis. We help J-8 operations divisions conduct analyses more quickly and reliably by providing advanced simulation and analysis tools and methodologies. The key activities being supported include (1) validation and verification of data and models during the various phases of an analysis; (2) application of object-oriented and agent-based techniques to modeling and simulation; (3) information and knowledge management; (4) development of modeling and simulation architectures that provide interoperability among legacy models, new models, and application packages; (5) development of logistics and deployment simulations; and (6) development of designs and applications for enhancing system security and evaluating new security technologies.

Analysis of logistics and mobility has become increasingly important to the U.S. military because of continuing rapid changes in the ways that forces are deployed. The objectives are lower costs, greater transparency, and more efficient management of the larger and more flexible logistic operations needed for modern warfare. Because more of the U.S. military is now stationed in the continental United States, greater importance is attached to contingency planning for deploying forces, both for missions such as disaster relief and peacekeeping and for military operations. Our work on logistics and deployment modeling and simulation has focused on four areas: developing prototype models and simulations, developing novel system architectures by integrating multiple model and simulation components, conducting technology feasibility studies, and providing technical guidance regarding technologies and systems designs.

The development of modeling and simulation architectures has been a primary focus of our work for the Joint Staff since 1987. One of the most useful results has been the Dynamic Information Architecture System (DIAS), an object-oriented simulation architecture capable of easily interfacing existing models and information processing applications. One notable application is an Integrated Ocean Architecture system that supports U.S. Navy operations.

Another major Argonne object-based framework, FACET (Framework for Addressing Cooperative Extended Transactions) supports the construction of models of complex, cooperative behavior by agents. FACET can be used to implement simulation models of organizational processes, such as the complex interplay of participating individuals and organizations engaged in multiple concurrent transactions in pursuit of their respective goals. Transactions can be patterned on, for example, business practices,

government and corporate policies, military standard operating procedures and doctrine, clinical guidelines, or office procedures. FACET can also incorporate other complex behaviors, such as biological life cycles or manufacturing processes.

For the Joint Staff, we are developing a tool that is being used to study interdiction strategies for countering the South American drug trade. The Complex Adaptive System Countermeasure Analysis Dynamic Environment-Counter Drug (CASCADE-CD) tool is intended to aid drug interdiction analysts in deriving and justifying force structure and operational planning recommendations. CASCADE-CD is an agent-based complex adaptive system simulation framework that models the trafficking aspects of the South American cocaine trade and the entire interdiction chain. Agents on both sides are provided with adaptive behaviors that are manifested at several scales and granularities.

4. U.S. Army

Argonne (in conjunction with the Department of Homeland Security) assists the Army's implementation of the Chemical Stockpile Emergency Preparedness Program (CSEPP). The Laboratory supports program development, policy analysis and development of associated guidance, emergency preparedness planning, institutional analysis, development of hazard-specific risk communications and emergency public education mechanisms, and testing and assessment of response capabilities. Argonne also assists in technical management. This work involves hazard analysis; modeling of chemical agent dispersion; development of cost estimation and measurement methodologies; integration of emergency planning; and collection, analysis, and validation of meteorological data at each CSEPP installation.

For the Operations Support Command, we are developing the Joint Munitions Planning System, a planning tool to support ammunition sourcing and movement strategies. This tool designs sourcing and movement strategies that best meet operational requirements established by battlefield commanders.

For the Army Environmental Center (AEC), Argonne is conducting research at a series of demonstration sites to develop techniques for the environmental characterization of contaminated installations and for monitoring *in situ* remediation in the continental United States. The research focuses on developing methodologies for characterizing groundwater pathways and contaminant plume configurations that will serve as models for other installations, thereby expediting the selection of remediation technologies and the cleanup or closure of bases at many sites.

We also support the AEC through R&D on environmental restoration at various Army installations, including several sites that have been placed on the National Priorities List. Specific activities include the development of state-of-the-art environmental data management systems to expedite remedial decision making and the use of groundwater and soil gas models to evaluate alternative methods of restoring aquifers. In addition, we support compliance and regulatory analyses for the AEC, including critical issues related to military munitions and environmental management of military ranges.

Argonne also helps the Army Corps of Engineers implement projects under Superfund and the Defense Environmental Restoration Program through the Savannah and Kansas City Districts. For the New York, Buffalo, and Omaha Districts, we are developing specialized approaches to remedial investigations and feasibility studies, particularly for sites having risk of radiological contamination and involving water resource restoration.

Argonne assists several districts of the Army Corps of Engineers in the efficient execution of the Formerly Utilized Sites Remedial Action Program, which was transferred from DOE to the Corps in FY 1998. The specialized technical capabilities we bring to this cleanup program include the Adaptive Sampling and Analysis Program (ASAP), the RESRAD code for dose assessment, expertise in approaches specified in the *Multi-Agency Radiation Survey and Site Investigation Manual*, multiplatform geophysical characterization, and advanced tools for management of environmental data.

We are conducting an integrated program of environmental and engineering research and technical support for the Army Corps of Engineers in the Mobile, Baltimore, and New England Districts and for the AEC, examining issues such as land restoration, solid waste management, site characterization, detection of buried objects, and cleanup of hazardous waste sites.

For the Army Soldier and Biological Chemical Command, we assist in the development and analysis of restrictions regarding the land disposal of chemical agents and their by-products in the environment. Studies are coordinated with multiple environmental agencies within the Army and with several states. We also support the Command's Assembled Chemical Weapons Assessment Program in the area of environmental compliance for demilitarization of assembled munitions, by exploring alternatives to incineration of material from the U.S. chemical agent stockpile. For the Chemical Demilitarization Program, we investigate chemical methods for (1) analyzing agent standards and waste streams and (2) detecting heavy metals in waste streams. In addition, we are employing models and analyses to address environmental management issues at the Command's Rocky Mountain Arsenal, Pueblo Depot Activity, Tooele Chemical Agent Disposal Facility, and Aberdeen Proving Ground.

We provide technical assistance for environmental restoration activities at Aberdeen Proving Ground, which has a legacy of chemical contamination. We are seeking solutions to such problems through a restoration study at the J Field site and through sitewide remote sensing. Work addresses management of environmental information, wetlands issues, and the natural attenuation of groundwater contamination.

We have undertaken studies of the environmental risks posed by active and former test ranges for the Army Developmental Test Command. We are now conducting specific environmental restoration and compliance assessment studies at three installations of the Command (Dugway Proving Ground, Yuma Proving Ground, and White Sands Missile Range).

For the U.S. Army Defense Ammunition Center (USADAC), a part of the Operations Support Command (OSC), we are developing a data system for hazardous waste characterization to support environmental compliance related to the destruction of munitions and explosives at Army installations and to the reuse and recycling of components. In related efforts, we are developing a demilitarization planning and management system that incorporates the USADAC system and other information to improve the Army's ability to plan for cost-effective and environmentally sound demilitarization. In addition, we perform specialized environmental modeling and data analyses to address radiological risk and restoration problems at OSC installations (currently the Seneca Army Depot). We are also developing the Joint Munitions Planning System, an advanced technology simulation tool for managing the global distribution of munitions.

For the Army National Guard, we provide specialized technical assistance in the analysis of issues related to the environmental management of military ranges, evaluation of the performance of cleanup remedies, innovative site characterization, and modeling of groundwater.

We continue to use our DIAS simulation architecture to design and develop integrated modeling systems for installation management by the U.S. Army. The DIAS architecture is most recently being used for a new U.S. Army initiative called Fort Future, which will develop the capability to model, simulate, assess, and optimize installations that can support transformation of the Army to meet future needs. In particular, DIAS will be the model integration framework for simulating and optimizing force projection for Fort Future. The system will also contain an air dispersion model for analyzing force protection.

Also for the Army, we are developing biological microchips (biochips) for use as sensors and detectors. In FY 2003 custom chips for detecting biological agents are being tested around the country, and new technology for on-chip PCR (polymerase chain reaction) amplification of phylogenetic and functional gene target nucleic acids is under continued development. We are developing methods of manufacturing biochips in enclosed flow cells and pursuing other advancements that will allow a single biochip to be used in the field either for custom analysis or PCR amplification.

5. U.S. Navy

We support the Naval Facilities Command (NAVFAC) and the Civil Engineer Corps Officer School in the area of ecological risk assessment, in part by transferring to the Navy restoration program the ecological risk assessment methodologies developed for DOE cleanup programs and also by developing information management systems to increase the efficiency of responses to ecological risk assessments. We also assess particular new cleanup methodologies and technologies. In addition, we provide technical leadership for NAVFAC characterization and risk assessment of depleted uranium in the environment of the Navy's China Lake facility.

6. Defense Threat Reduction Agency

As part of its R&D program in support of arms control and homeland security, we develop treaty verification and threat attribution procedures and technology for the Defense Threat Reduction Agency. Currently, our verification programs focus on the overall long-term information and organizational requirements for verification, validation, and compliance as additional treaties are being implemented. This activity includes analysis of functional requirements, technical evaluation, independent verification, and validation for new automated systems; prototyping for automated training techniques; and assistance in implementation planning. We also conduct life cycle analyses in support of strategic planning for arms control treaty software systems and perform studies and technical evaluations in support of the Open Skies Treaty. Recent additions to the homeland security component of this program include an investigation of methods for attributing a domestic nuclear threat to its perpetrators and a project to evaluate and develop biological microarrays for detecting and analyzing potential biological threats.

7. Defense Advanced Research Projects Agency

For the Defense Advanced Research Projects Agency, we are developing oxide thin-film technology for radar and communications systems. We are also investigating toxin removal from the bloodstream by magnetic particles, as well as biomagnetic self-assembly with virus technology.

8. Joint Program Office for Special Technology Countermeasures

For the Joint Program Office for Special Technology Countermeasures, we are (1) identifying, collecting, and synthesizing data about the U.S. natural gas, petroleum fuels, and water infrastructures and (2) developing and applying analytical tools for isolation and system analyses. In addition, we are examining trends in the petroleum refining industry, modeling infrastructure interdependencies as complex adaptive systems, and examining risk-based decision methodologies. The overall objective is a capability to identify susceptibilities and operational dependencies in critical infrastructure that, if not remedied, could threaten accomplishment of vital military missions.

C. Department of Health and Human Services

Funding for Argonne's work for the Department of Health and Human Services either flows through the University of Chicago or is received directly through interagency agreements with DOE. (In Chapter VI see University of Chicago Grants and Department of Health and Human Services, respectively.)

University of Chicago Grants

The National Institutes of Health (NIH) supports a broad range of fundamental studies at Argonne. These investigations often apply techniques developed in DOE-supported programs to studies in structural biology, biophysics, carcinogenesis, mutagenesis, and physiology. In turn, our work for NIH benefits our resources for addressing the DOE science mission, including the DOE Genomes to Life program. Most of our studies for NIH emphasize structure-function relationships or mechanisms underlying biological responses.

Our biophysical studies for NIH are addressing the properties of human antibody light chains that lead to pathologic deposition in myeloma. Investigations of *in vitro* aggregation of light chains consider their structure and pathologic characteristics. For example, one project is developing new procedures for the heterologous expression of functional membrane proteins in quantities sufficient for x-ray crystallography to determine the proteins' structures and functions.

We are among the initiators of the U.S. structural genomics program. NIH now is supporting a major effort in structural genomics at Argonne, with an ultimate goal of determining the structures of all protein families. This effort for NIH, in partnership with the DOE-funded Structural Biology Center (SBC) at the Advanced Photon Source (APS), created the Midwest Center for Structural Genomics (MCSG). Argonne is the lead institution in the MCSG consortium, which also includes six universities. NIH will provide approximately $5 million annually through FY 2005 to establish high-throughput methods for determining the three-dimensional structures of proteins from bacteria and higher eukaryotes. As recently as 1990, solving a single protein crystal structure could take one or more scientists several years. At Argonne, improved techniques for data collection, analysis, and structural determination now allow the structure of a protein to be solved in as little as six hours. Using x-rays from the APS, the SBC collects data of very high quality significantly faster than was possible even a few years ago. By developing (1) robotic methods to carry out tedious experimental procedures and (2) advanced computational methods for data analysis and structure determination, we have achieved huge leaps in productivity. The MCSG is continuing to develop high-throughput methods in molecular biology, protein purification, and crystallization. Combined with highly efficient SBC beamlines and automated crystallography, these methods will further accelerate the process of determining new protein structures. NIH support of the MCSG will enable further major improvements in productivity.

We are collaborating with the University of Chicago Medical School to develop an ice slurry treatment that will decrease cell death due to reduced blood flow and oxygen availability after cardiac arrest or stroke. A medical-grade slurry is used to cool the brain and heart rapidly and induce hypothermia. NIH recently funded a five-year project for further development of the coolant and associated clinical procedures.

In other work, NIH supports Argonne's development of models that simulate turbulence in the carotid artery. This effort, conducted by Argonne computer scientists in collaboration with researchers at the University of Illinois at Chicago and the University of Chicago, aims to help physicians make treatment decisions tailored to individual patients.

We will contribute to improving national defense against biological warfare as a member of the NIH-funded Midwestern Regional Center of Excellence for Biodefense and Emerging Infectious Diseases Research (RCE). This multidisciplinary, multisite effort focuses on the diseases anthrax, botulism, hemorrhagic fever, plague, and tularemia. Led by the University of Chicago and Northwestern University, the RCE involves multiple universities, research institutes, and public health authorities and more than 100 scientists — including several from Argonne. Central objectives are to improve basic understanding of the diseases' pathogenesis, create novel therapeutics, develop vaccines or other preventive strategies, and develop better diagnostic technologies. Argonne is proposing projects to investigate (1) whether genetic determinants essential to the pathogenesis of anthrax disease can serve as targets for therapy; (2) bioinformatics analysis of certain important genomes, along with metabolic and pathogenic reconstruction; (3) use of affinity imprinting to develop a new system for detecting hemorrhagic fever viruses; and (4) development of a powerful data analysis and computational environment for use by RCE participants. In addition, the Laboratory is to contribute to overall administration of the center.

To support the RCE, a Regional Biocontainment Laboratory (RBL) is to be built at Argonne through a proposal by the University of Chicago to NIH. This laboratory will provide RCE researchers with facilities certified to "biosafety level 3" (the third highest of four levels). Placing the RBL at Argonne will ensure ready access to complementary Argonne facilities such as the APS, the SBC, the MCSG (with its focus on rapid

selection, robotic generation, purification, crystallization, and structural analysis of proteins), the Mathematics and Computer Science Division (for information analysis and modeling), and the Center for Nanoscale Materials.

Interagency Agreements with DOE

The National Institutes of Health is also partnering with Argonne to construct and operate a new collaborative access team (GM/CA-CAT) at the APS. This effort will parallel and cooperate with the SBC and the MCSG. Utilizing two undulators and a bending magnet, GM/CA-CAT will develop three x-ray beamlines optimized for macromolecular crystallography. Office and laboratory space for staff and users has been developed in a new office-laboratory module to be constructed at the APS. The beamlines will include high-throughput robotic sample delivery, high-speed data collection with online analysis, and remote access through interactive computer networks. Construction of the beamlines, begun in FY 2003, will proceed in two sequential phases that will allow data collection at the first beamline to begin during construction of the other two beamlines.

Argonne provides technical support to the U.S. Public Health Service, Division of Federal Occupational Health, in the development and implementation of an environmental health and safety assessment program for the U.S. Social Security Administration. The principal objective is to develop an overall program framework, plans and protocols, and facility assessments at randomly selected facilities in ten regions. Information gathered during pilot assessments in a few regions will be used to guide subsequent work.

D. Other Federal Agencies

1. Environmental Protection Agency

We apply our DIAS architecture as the framework for ecosystem modeling and environmental health assessment through a U.S. Environmental Protection Agency (EPA) system known as MIMS (Multimedia Integrated Modeling System). MIMS allows researchers to consider the environment for nutrients and chemicals across air, water, and land. We are also helping the EPA develop a prototype multicompartment model within MIMS.

For the EPA Office of Pollution Prevention and Toxics and EPA Region V, we are extending methods of analyzing cumulative environmental risks in urban areas by enhancing the availability and performance of scientifically sound procedures, models, analytical tools, and guidelines. One objective is to identify areas within the metropolitan Chicago region where exposures of the general population to individual pollutants or combinations of pollutants might be significant.

For the EPA Office of Research and Development (ORD) at the National Center for Environmental Assessment, we are evaluating and implementing methodologies related to assessing cumulative risks, including risk of exposures to chemical mixtures by multiple pathways. Applications to DOE sites are being demonstrated. For the National Homeland Security Research Center at EPA-ORD, we are developing rapid risk assessment methods.

We will assist the EPA Technology Innovation Office with its Triad Program of systematic planning, dynamic work plans, and field analytics, which aims to accelerate environmental cleanup by employing Argonne's experience with adaptive sampling, expedited characterizations, and brownfield sites. This effort may include support to EPA regional offices.

For the EPA Office of Radiation and Indoor Air, we are assisting in the evaluation of technologies and methods for detecting and analyzing radioactive contamination in imported scrap metal. A pilot study at the ports of New Orleans and Charleston included deployment of a detection system and analysis of imported scrap metal.

For the EPA Office of International Activities, we are evaluating thermal destruction technologies to treat persistent organic pollutants, including polychlorinated biphenyl compounds and obsolete pesticides. The technology is to be demonstrated in the Russian Federation. Results are expected to benefit DOE sites directly.

2. Federal Emergency Management Agency

Our support to the Federal Emergency Management Agency involves three major areas relating to accidental or deliberate releases of chemical, biological, and radiological materials: (1) analysis and evaluation of the capabilities of U.S. industry, nearby communities, and host states to respond to emergencies involving the materials; (2) R&D on guidance for emergency planning, exercises to test emergency plans, and response activities; and (3) the development and conduct of training activities.

3. Department of State and International Atomic Energy Agency

Throughout most of its existence, Argonne has actively supported the worldwide transfer of peaceful applications of nuclear technology. Shortly after the Laboratory was founded, the first international training activities were established as part of the Eisenhower Atoms for Peace program. Participants came from throughout the world to learn about the new, rapidly developing field of nuclear reactor technology. In many countries, graduates are today the leaders of national programs involving the peaceful applications of nuclear technology.

In 1976 we were designated by the Department of State as host institution for U.S. participation in the new Nuclear Power Training Program of the International Atomic Energy Agency (IAEA). Under this program we today continue to develop, organize, and conduct training courses covering a full range of topics in the peaceful applications of nuclear technology. Subject areas include nuclear safety, security and research reactor safety, D&D, energy planning, nuclear electronics, isotope hydrology, and medical physics. Approximately 3,000 professionals from over 100 countries, representing essentially all developing member states of the IAEA, have received intensive training through these courses.

We provide technical and management support to the Department of State and directly to the IAEA. One major activity is evaluation of technical cooperation projects proposed for funding by the United States, along with monitoring and facilitation of the implementation of such projects once funded. We developed and now maintain — by means of an electronic database — an "institutional memory" of U.S. support for technical cooperation projects, as well as extensive project files, IAEA reports, and evaluation studies. We also support the Department of State and the IAEA in their initiatives to improve the agency's technical cooperation program. Argonne regularly reviews and analyzes the program's management and achievements. We also develop recommendations on matters of policy or practice related to U.S. support for the program. By providing experts for technical cooperation programs, Argonne has helped many countries develop the ability to analyze the operation of their energy systems.

We also support the Department of State by placing IAEA fellows at research institutions throughout the country.

4. Department of Transportation

For the Research and Special Projects Administration, we continue to model the effects of accidents resulting from transportation of chemicals on the nation's highways and railways. These models will address (1) the effectiveness of establishing protective distances from accidents involving spills on highways and rails and (2) chemical spills into bodies of water from highway and rail accidents. In support of regulation development, the Laboratory is involved in a national assessment of risks (especially risks through inhalation) associated with transporting toxic chemicals.

5. Department of Agriculture

As part of an ongoing program for the Commodity Credit Corporation of the U.S. Department of Agriculture (CCC/USDA), Argonne supports remediation of sites having contaminated groundwater and soil by integrating field sampling, groundwater modeling, and engineering cost analyses. We are also developing new cone penetrometer technologies and using them — in combination with innovative sampling,

analytical, and computer data processing methods — to map the subsurface distribution of contaminants in soils and groundwater at former CCC/USDA grain storage sites. In addition, we are conducting pilot studies of spray irrigation as an alternative to traditional methods of treating contaminated groundwater.

We are assisting in the technical development of the Research, Education, and Economics Information System (REEIS), a "data mart" that integrates multiple databases in the USDA's Research, Education, and Economics program by using a web-based information architecture. REEIS will improve access to information by employing a consistent, integrated framework and will provide automated tools for analyzing the information.

The U.S. Forest Service, DOE's Argonne Area Office, and Argonne have signed a master interagency agreement that facilitates the use and application of Laboratory technical resources to support management of the nation's forests and grasslands.

6. National Science Foundation

Funding for most Argonne work for the National Science Foundation (NSF) flows through universities (see Chapter VI).

We are a partner in the National Computational Science Alliance, funded by the NSF Partnerships for Advanced Computational Infrastructure program. Researchers are developing software for collaborative problem solving, distributed computing technology, advanced visualization tools, and parallel input-output technology.

We are one of five institutions participating in the TeraGrid project, which aims to develop the world's first multisite supercomputing system, the Distributed Terascale Facility. The TeraGrid is led by the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign and by the San Diego Supercomputer Center, two leading sites of NSF's Partnerships for Advanced Computational Infrastructure. By integrating the most powerful computers, software, networks, data-access systems, and applications, the TeraGrid will create a unique national resource to support scientific breakthroughs.

As a world leader of emerging grid technologies, we collaborate on several NSF-funded projects, including the Network for Earthquake Engineering Simulation project with the NCSA; the GRIDS Center project with the University of Chicago, the University of Southern California Information Sciences Institute, the University of Illinois at Urbana-Champaign, and the University of Wisconsin; and the Grid Physics Network project with more than two dozen U.S. universities.

We are also pursuing several smaller computer science projects funded by NSF, including development of extensible network services for the Access Grid, design of adjoint compiler technology, and development of a Java commodity toolkit for computational grids.

We are collaborating with other NSF projects to develop the National Science Digital Library. In particular, under NSF funding we are leading Eastern Illinois University and the University of Utah in producing a digital library collection that improves the accessibility and usability of DOE Atmospheric Radiation Measurement Program data for the education and research communities.

7. National Aeronautics and Space Administration

For the National Aeronautics and Space Administration (NASA), Argonne is developing test beds to study applications of distributed computational grids. Argonne researchers, together with investigators at the University of Southern California's Information Sciences Institute, are also teaming with NASA researchers to implement Globus Toolkit technology on the NASA Information Power Grid.

For NASA we are also developing an Earth systems modeling framework for coupled climate models used in simulating climate variability and change.

In addition, Argonne is building a state-of-the art laboratory for trace element detection to study the composition of interstellar dust from

supernovas and from comet tails, as well as the composition of components of the solar wind retrieved from Earth satellites. These studies will reveal secrets of the origin and evolution of the universe.

In other work for NASA, Argonne is providing technical assistance and oversight for the Plum Brook Reactor Facilities Decommissioning Project. Four Argonne staff members are serving in the areas of management of construction, quality assurance, health and safety, and radiation safety. This project is expected to continue until 2007.

For use in advanced propulsion systems and outer shells for high-speed aircraft, NASA is investigating advanced ceramic composite materials. In support of this effort, we are developing noncontact, nondestructive test methods to determine the condition of the materials before, during, and after a test cycle.

8. Department of Commerce

Argonne works with two organizations within the Department of Commerce: the National Oceanic and Atmospheric Administration and the National Institute of Standards and Technology (NIST).

The NIST Advanced Technology Program (ATP) requires participating private companies to match NIST funding. The private sector can then choose to subcontract to the national laboratories in the pursuit of new technology. (See Section S1.E.2.)

9. Department of the Interior

We provide technical support on environmental issues to the Bureau of Land Management (BLM) of the Department of the Interior, helping BLM maintain long-term stewardship of public lands while allowing production of resources such as oil and natural gas.

We are developing atmospheric dispersion models that will evaluate the effects on regional air quality resulting from enhanced methane production from coal beds in the Powder River Range of Wyoming. We are also funded directly by DOE to support BLM energy planning in the Farmington (New Mexico) and Worland (Wyoming) field offices. These projects test new tools designed to enhance data sharing and provide baseline measurements needed for energy development. For BLM we also conducted several technical studies, and in FY 2003 we completed an environmental impact statement for renewal of the right-of-way for the Trans-Alaska Pipeline System. (As indicated in Section S1.E.2, this work was funded by Alyeska Pipeline Service Company.)

For the Interior Department's Fish and Wildlife Service, we develop environmental information and communications systems. One of the systems is being developed jointly with the Chicago Wilderness Society.

E. Nonfederal Organizations

1. Electric Power Research Institute

Argonne conducts research for the Electric Power Research Institute (EPRI) on topics related to the risk of a severe accident at a nuclear power plant. Research for the Melt Attack and Coolability Experiment (MACE) program was particularly important. This work investigated the ability of water to quench and cool a pool of molten core debris without formation of a continuous insulating crust, thereby terminating an accident and preventing basemat penetration. The investigations attracted worldwide attention because of their importance to strategies for managing accidents at existing plants and their great relevance to design decisions for future light-water reactors. These experiments were sponsored by the 15-nation Advanced Containment Experiments program headed by EPRI, which pursued realistic understanding of the consequences of an accident involving core melting. A successor to the MACE program is now being conducted under the sponsorship of the Organization for Economic Cooperation and Development. (See discussion of the Melt Coolability and Concrete Interaction program in Section S1.E.5.)

Complementary Argonne programs for EPRI aim to resolve key safety issues through a

combination of analysis and experiments. The recently developed computer code CORQUENCH, based on data from Argonne experiments, is being used to analyze accident phenomena.

Other work for EPRI includes identifying and characterizing technologies and processes for mitigating the environmental impacts of cooling water intake structures at electric power plants. We also assess the use of these technologies and processes in innovative approaches to meeting environmental regulations (e.g., integrating methods such as wetlands restoration, artificial reefs, and artificial supplementation of aquatic systems into strategies such as wetlands banking and effluent trading).

2. Private Firms

We conduct research for a number of private firms, making use of our unique facilities and technical resources. Current work for private firms includes the following:

- Alyeska Pipeline Service Company: An environmental impact statement on renewal of the right-of-way for the Trans-Alaskan Pipeline System, for submittal to the BLM.
- BASF Corporation: Production of specialty chemicals in pilot plant quantities to test a new process using electrodialysis.
- Climax Molybdenum: Development of hydrosulfurization catalyst materials.
- General Atomics: Development of a tile computer display wall.
- General Motors Electro-Motive Division: Improvement of the efficiency and emissions characteristics of diesel engines.
- General Motors Global Alternative Propulsion Center: For advanced vehicles and fuel propulsion systems, analysis of "well-to-wheel" energy efficiencies and emissions of greenhouse gases and criteria pollutants.
- IBM: Development and implementation of the Open Grid Services Architecture, a set of specifications and standards that will combine the benefits of grid computing and web services.
- Kraft Foods: Application of nuclear magnetic resonance technology to study water distribution in processed cheeses.
- Microsoft: Development of Globus Toolkit libraries for Windows XP; porting of elements of the Access Grid Toolkit to Windows XP.
- NRG Energy, Inc.: Environmental impact analysis for a 500-kV transmission line.
- Quallion, LLC: Development of an advanced battery for implantable micro-stimulator devices for patients with strokes and Parkinson's disease. (Funding is from the NIST ATP.)
- Solar Turbines, Inc.: Application of new nondestructive evaluation technologies to ceramic materials being developed for gas-fired turbine engines that emit less pollution and operate more efficiently.
- Superior Graphite Company: Development of nonintrusive controls for an electro-consolidation process intended to replace hot isostatic pressing in the forming of mechanical components. (Funding is from the NIST ATP.)
- Toyota Motor Corporation: Development of water-gas shift catalysts for use in fuel processors for fuel cell systems.

In addition to the activities administered under Argonne's WFO program, as discussed in this Supplement 1, the Laboratory also performs work with its partners in cooperative research and development agreements (CRADAs). These activities are discussed in Supplement 2.

Argonne's work for private firms often grows out of industry-laboratory collaborative projects. A good example is the Argonne Laser Applications Laboratory, which conducts R&D to support the use of high-power lasers. A recent project with the Gas Technology Institute could revolutionize the way we obtain new oil and gas supplies. The project is investigating the use of laser energy in well drilling and well completion techniques. Other projects relate to materials processing for manufacturing, such as laser heat treatment of casting dies. Processing techniques available at the Laser Applications Laboratory include high-power beam shaping and delivery, fiber optics, surface modification, and welding.

Industrial partners include automotive manufacturers and suppliers and also several small businesses. One example of benefits to private firms is a low-cost weld monitor being used in a DaimlerChrysler plant in Kokomo. This monitor has saved millions of dollars by improving weld quality. Work by the Laser Applications Laboratory generally supports Argonne's major facilities and programs, such as the APS, the Intense Pulsed Neutron Source, the fusion power program, and D&D of reactor systems. Current work focuses on applying laser ablation in D&D funded by DOE's Environmental Management Science Program.

3. Universities

Current Argonne work for universities includes the following:

- Indiana University: A high-performance network connection for research and education.
- Northern Illinois University: Collaboration on the development of MPICH-G2, a grid-enabled implementation of the Message Passing Interface standard that enables communications between machines having different architectures.
- Northwestern University: Participation in the Optimization Technology Center.
- Northwestern University: Educational outreach to place Illinois undergraduate students in summer research participation positions at the APS.
- Northwestern University: Development of innovative robotic control technology for remote applications in hazardous environments.
- Penn State University: Support for the design and engineering of a cold-neutron multichopper spectrometer for neutron scattering, to be installed at the Spallation Neutron Source at Oak Ridge National Laboratory.
- University of Chicago: Collaboration on the Grid Physics Network project in the areas of data grid and virtual data research, toolkit development, application challenge problems, and outreach.
- University of Chicago: Development of slurry ice cooling for treating cardiac patients.
- University of Chicago: As part of the Illinois Consortium of Accelerator Research project, technical support involving theoretical and simulation analysis of beam dynamics problems that are critical for the performance of linear colliders.
- University of Illinois at Urbana-Champaign: The Partnership for Advanced Computational Infrastructure program.
- University of Illinois at Urbana-Champaign: Assistance in developing middleware communication services for grid-based collaborations for the project Network for Earthquake Engineering Simulation.

4. State and Local Government

For the state of Illinois, Department of Commerce and Economic Opportunity, we are developing an advanced, high-capacity computer network (I-WIRE) linking major research centers and universities in the state. The network will enable detailed power and engineering feasibility studies, as well as development of advanced interfaces for geographically distributed applications.

We are working under two additional programs with the Illinois Department of Commerce and Economic Opportunity. The first involves developing biobased "green" solvents, such as ethyl lactate from corn and methyl soyate from soybeans, for industrial applications. In the second project, we are using our widely accepted GREET (Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation) model to estimate full fuel-cycle energy use and emissions from ethanol blends that may be used for light- and heavy-vehicle diesel propulsion.

For the Illinois Commerce Commission, we are analyzing the state's electric power transmission system by using a new modeling and simulation approach we developed to study complex adaptive systems.

In another project, we are working with DuPage County, Illinois, to develop precollege educational materials focused on recycling.

State groundwater regulatory agencies are prominent members of the nonprofit Ground Water Protection Council, along with federal agencies and other parties interested in protecting the nation's groundwater supplies. Argonne's work for the council involves preparing environmental analyses and developing environmental information management systems, all with a focus on the relationship of energy systems to groundwater protection.

5. International Organizations and Foreign Countries

With the World Bank and countries borrowing from the Bank, we are working on energy and environmental analyses addressing issues such as planning least-cost expansions for electrical generating systems, estimating marginal costs of electricity production, simulating the operation of mixed hydrothermal systems, projecting overall energy supply and demand, analyzing current and future environmental effects of energy production and consumption, estimating the potential for future pollution abatement projects and their costs, and estimating the costs and effects of greenhouse gas mitigation options. We typically conduct these studies in close cooperation with experts in the borrowing countries, who often are trained to use the analytical techniques themselves.

To advance nuclear reactor technology, international sponsors utilize Argonne's unique capability to perform severe-accident experiments with real reactor materials. We currently work with Atomic Energy of Canada, Ltd., on an experiment to explore molten fuel-fluid interaction for the CANDU reactor. We are conducting other accident-related research as part of the Melt Coolability and Concrete Interaction program sponsored by the Organization for Economic Cooperation and Development. The technical objectives of this multiyear program are to investigate the mechanisms by which debris cools outside the containment vessel and to address remaining uncertainties related to long-term, two-dimensional interactions between the reactor core and concrete. These objectives will be met through a series of experiments.

In other work, the Japan Nuclear Cycle Development Institute supports studies of the operational characteristics of reactor concepts, the testing needed for advanced fuels, and the irradiation behavior of materials. The Central Research Institute of the Electric Power Industry of Japan (CRIEPI) also supports studies of the irradiation behavior of structural materials. Argonne will work with CRIEPI on gathering and analyzing research data relating to the behavior of actinides and fission products in the electrometallurgical treatment of spent fuel. Argonne collaborates with the Korea Atomic Energy Research Institute (KAERI) on several aspects of nuclear reactor technology, safety research, and advanced computing applications. We are also working with KAERI on International Nuclear Energy Research Initiatives (1) to evaluate structural materials for use in the pyrochemical processing of spent nuclear fuels and (2) to evaluate and develop materials for use in Generation IV supercritical-water reactors.

We work directly with many foreign countries to provide energy and environmental analyses, along with training in the use of supporting computer models. Included are two Argonne models, the ENergy and Power Evaluation Program (ENPEP) and the Generation and Transmission Maximization (GTMax).

In a major project we work with countries in eastern Europe (Romania, Bulgaria, Macedonia, Albania, Serbia, Montenegro, Croatia, and Bosnia-Herzegovina) to analyze the operation of their electric power systems as integrated entities rather than as separate systems. The objective is improving economic and operational efficiency. The project involves the U.S. Agency for International Development and the World Bank.

Argonne is the operating agent for the International Energy Agency program Implementing Agreement for a Co-Operative Programme for Assessing the Impacts of High-Temperature Superconductivity on the Electric Power Sector. The Laboratory's main role is to keep member countries informed about the status of superconductivity research and its progress toward application. The implementing agreement is

funded by organizations in 16 countries, including the United States.

We are collaborating with researchers at the European particle physics center at CERN on the DataGrid Project to build the next-generation computing infrastructure for handling computation and analysis of petabyte-scale databases across widely distributed scientific communities. This work will build on technologies developed by Argonne's Globus Project™. Researchers in the Globus Project™ are also working with the Poznan Supercomputing and Networking Center in Poland to develop GridLab. Globus Toolkit services and libraries, such as GridFTP and Globus Resource Allocation and Management, will be used to support the development of dynamic grid-enabled applications. In addition, Argonne's Globus Project™ has formed a collaboration with the University of Manchester on the GRid Interoperability Project (GRIP). The aim is to develop a software layer that will enable secure resource management across different grids, specifically grids controlled by UNICORE and Globus Toolkit technologies.